PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
116814/TLW/jmz		
International Application No.	International Filing Date *(day/month/year)*	Priority Date *(day/month/year)*
PCT/AU2003/001641	10 December 2003	10 December 2002

International Patent Classification (IPC) or national classification and IPC

Int. Cl. [7] G01N 23/10, G01V 5/00, G01T 1/16, 3/00

Applicant

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION et al

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheet(s).

3. This report contains indications relating to the following items:

   - I [X] Basis of the report
   - II [ ] Priority
   - III [ ] Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV [ ] Lack of unity of invention
   - V [X] Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI [ ] Certain documents cited
   - VII [ ] Certain defects in the international application
   - VIII [ ] Certain observations on the international application

Date of submission of the demand	Date of completion of the report
9 July 2004	22 March 2005
Name and mailing address of the IPEA/AU	Authorized Officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	**GREG POWELL** Telephone No. (02) 6283 2308

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU2003/001641

I. Basis of the report

1. With regard to the elements of the international application:*

☐ the international application as originally filed.

☒ the description, pages **1-23,** as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages **24-27,** filed with the demand,
pages , received on with the letter of

☒ the drawings, pages **1/13-13/13,** as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the **language,** all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages

☐ the claims, Nos.

☐ the drawings, sheets/fig.

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-27	YES
	Claims		NO
Inventive step (IS)	Claims	1-27	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-27	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Claims 1-27 meet the criteria set forth in PCT Article 33(2)-(4) for novelty, inventive step and industrial applicability. The prior art cited in the ISR does not disclose radiographic equipment having the features defined in the claims. In particular, no individual citation or obvious combination discloses a slot-collimated neutron and source beam together with an aligned collimated detector array.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of Box I

The amendments to claim 25 are considered to go beyond the original disclosure because the new claim adds the feature of rotating the object relative to the sources and detector array. The original application only had support for rotating the sources and detector array (see page 20 lines 15-17).

CLAIMS:

1. Radiographic equipment comprising:

a source of substantially mono-energetic fast neutrons produced via the deuterium-tritium or deuterium-deuterium fusion reactions, comprising a sealed-tube or similar generator for producing the neutrons;

a source of X-rays or gamma-rays of sufficient energy to substantially penetrate an object to be imaged;

a collimating block surrounding the neutron and X-ray and gamma-ray sources, apart from the provision of one or more slots for emitting substantially fan-shaped radiation beams;

a detector array comprising a multiplicity of individual scintillator pixels to receive radiation energy emitted from the sources and convert the received energy into light pulses, the detector array aligned with the fan-shaped radiation beams emitted from the source collimator and collimated to substantially prevent radiation other than that directly transmitted from the sources reaching the array;

conversion means for converting the light pulses produced in the scintillators into electrical signals;

conveying means for conveying the object between the sources and the detector array;

computing means for determining from the electrical signals the attenuation of the neutrons and the X-ray or gamma-ray beams and to generate output representing the mass distribution and composition of the object interposed between the sources and detector array; and

display means for displaying images based on the mass distribution and the composition of the object being scanned.

2. Radiographic equipment according to claim 1, where the X-ray or gamma-ray source comprises a 137Cs, 60Co or similar radioisotope source having an energy of substantially 1 MeV.

3. Radiographic equipment according to claim 1, where the X-ray or gamma-ray source comprises an X-ray tube or electron accelerator producing X-rays through Bremsstrahlung on a target.

4. Radiographic equipment according to any one of the preceding claims, where the neutron source produces neutrons having substantially higher energies than the X-ray or gamma-rays from the X- ray or gamma-ray source, where the neutron and X-

ray or gamma-ray sources are arranged to pass through the same slot in the collimating block and a single detector array is used, comprising individual pixels of plastic or liquid organic scintillator, where discrimination between the gamma-rays and the neutrons is made on the basis of the energy they deposit in the scintillator.

5. Radiographic equipment according to any one of claims 1 to 3, where the sources of neutrons and X-ray or gamma-rays are arranged to pass through the same slot in the collimating block and a single detector array is used comprising individual pixels of plastic or liquid organic scintillator, where the neutron and X-ray or gamma-ray sources are operated alternately.

6. Radiographic equipment according to any one of claims 1 to 3, where the sources of neutrons and X-ray or gamma-rays are arranged to pass through separate parallel slots in the collimator block and two detector arrays are used, one comprising individual pixels of plastic or liquid organic scintillator for the detector of the neutrons and one comprising individual pixels of plastic, liquid or inorganic scintillator for detection of the X-rays or gamma-rays.

7. Radiographic equipment according to any one of claims 4 to 6 where each slot of the source and detector collimators are sufficiently wide to ensure full illumination of the detectors by the source, whilst minimising the detection of scattered radiation.

8. Radiographic equipment according to claim 1, further comprising a second sealed tube or similar neutron source producing neutrons via either the deuterium-tritium or deuterium-deuterium fusion reactions, where the second source uses the complementary fusion reaction to the first source.

9. Radiographic equipment according to claim 8, where the neutrons from the second neutron source are detected in a separate collimated detector array comprising individual pixels of plastic or liquid organic scintillator.

10. Radiographic equipment according to claim 9, where one of the first or second source of neutrons has an energy of substantially 14 MeV and the other source of neutrons has an energy of substantially 2.45 MeV.

11. Radiographic equipment according to any one of the preceding claims, where the conversion means comprises a plurality of photodiodes, wherein the scintillator

material is selectable to have an emission wavelength substantially matched to the response of the photodiodes.

12. Radiographic equipment according to any one of the preceding claims, where the conversion means comprises crossed wavelength shifting fibres coupled to a multiplicity of single or multi-anode photomultiplier tubes.

13. Radiographic equipment according to claim 11 or claim 12, where the electrical signals from the conversion means are used to infer the transmission of the neutrons from the neutron source and the X-rays or gamma-rays through the object being scanned, or the transmission of the neutrons from the first neutron source, the X-rays or gamma-rays and the neutrons from the second neutron source through the object being scanned.

14. Radiographic equipment according to claim 13, where the transmissions are used to compute mass attenuation coefficient images for each pixel for display with different pixel values mapped to different colours, the image based on the mass distribution and composition inferred from these computations.

15. Radiographic equipment according to any one of the preceding claims, where the computing means comprises a computer to perform image processing and display the images on a computer screen.

16. Radiographic equipment according to claim 15, where the output is convertable to mass-attenuation coefficient images for each pixel for display on a computer screen with different pixel values mapped to different colours.

17. Radiographic equipment according to claim 16, where the mass-attenuation coefficient images are obtainable from count rates measured from the transmissions for each of the deuterium-tritium neutrons or deuterium-deuterium neutrons and X-rays or gamma-rays, or the deuterium-tritium neutrons, deuterium-deuterium neutrons and X- rays or gamma-rays.

18. Radiographic equipment according to claim 17, where the computer is operable to obtain cross section ratio images between pairs of mass attenuation coefficient images.

19. Radiographic equipment according to claim 18, where the proportions in which the cross section ratio images are combined are adjustable to maximise contrast and sensitivity to a particular object being examined in the image.

20. Radiographic equipment according to claim 18 or claim 19, where the computer is able to perform automatic material identification based on the measured cross sections.

21. [New] Radiographic equipment according to claim 19, where the proportions in which the cross section ratio images are combined are operator adjustable.

22. [Amended] Radiographic equipment according to any one of the preceding claims, where the sources and the detector array are stationary and the transport mechanism is arranged such that the object is able to be moved in front of the source of neutrons.

23. [Amended] Radiographic equipment according to any one of claims 1 to 21, where the object is stationary and the transport mechanism arranged such that the source and the detector array move in synchronicity either side of the object.

24. [Amended] Radiographic equipment according to any one of claims 1 to 21, where multiple sets of detectors are situated around the sources which are centrally located to allow scans of a plurality of separate objects to be acquired simultaneously.

25. [Amended] Radiographic equipment according to any one of claims 1 to 21, where multiple views are obtained by either rotating the object relative to the sources and the detector array or by rotating the sources and the detector array relative to the object.

No disclosure

26. [Amended] Radiographic equipment according to any one of the preceding claims, where the intensity of either the deuterium-deuterium and/or deuterium-tritium neutron sources is of the order 1010 neutrons/second or as high as practically possible.

27. [Amended] Radiographic equipment according to claim 11 where the scintillators are surrounded by a mask to cover at least a portion of each of the scintillators, each mask having a first reflective surface to reflect escaped light pulses back into the scintillator.